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Short sleep duration is dose-dependently related to job strain and burnout in nurses: A cross sectional survey☆

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ABSTRACT

Objectives: Lack of sleep is a common problem amongst nurses. Short sleep duration has been related to stress and burnout. However, in nurses, the effects of short sleep duration on job strain and burnout are controversial and a clear relationship has been lacking. This study aims to assess whether short sleep duration is related to job strain and burnout statue, and whether such relationship is in a dose-dependent manner.
Methods: A cross-sectional survey among female nurses in secondary referral health centers in Taiwan, using a self-administered structured questionnaire. Stratified sampling by region and patient bed number category was done to select representative centers for this survey. Approximately 10% of all secondary referral centers were randomly selected from each stratum. Non-linear dose–response relationship between sleep duration and job strain and burnout scores was assessed by general additive models (GAM), adjusting for personal characteristics, work condition, and family situation.
Results: Among the 2268 full-time nurses in 39 hospitals invited to participate in this study, 1384 (61%) satisfactorily completed the questionnaire. There were 169 nurses (12.2%) who slept less than 6 h per working day. Among the participants, 37% ($n = 512$) were classified into high strain group. The mean scores of personal, work-related, and client-related burnout were 59.4 (SD = 22.0), 54.6 (SD = 21.7), and 42.3 (SD = 18.6). Compared to those slept longer than 7 h, nurse who slept less than 6 h per working day had higher risk for job strain (adjusted odds ratio, AOR = 1.8, 95% confidence interval, CI = 1.2–2.7), personal burnout (AOR = 3.0, CI = 1.7–5.2), work-related burnout (AOR = 3.4, CI = 2.0–6.0), and client-related burnout (AOR = 2.0, CI = 1.2–3.6). GAM analysis found a linear relationship between sleep duration and job strain, and client-related burnout. For

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personal and work-related burnout, a linear increase in burnout score between 7 h and 5 h of sleep was observed, followed by a leveling off for durations of less than 5 h.
Conclusion: Our study found sleep duration at working days was inversely associated with female nurses' job strain and burnout in a dose-dependent manner. Further studies on work factors which affecting sleep duration are warranted.

What is already known about the topic?

- Nurses are at high risk of job strain and burnout.
- Nurses' job strain and burnout status not only affect patients' satisfactions, but patients' safety.
- Lack of sleep in common amongst nurses.

What this paper adds

- A clear inverse relationship exists between sleep duration and job strain and burnout.
- Seven hours seems to be an optimal duration of sleep considering minimizing nurses' job strain and burnout.

1. Introduction

Nurses belong to a profession that has high exposure to job strain and burnout (Felton, 1998; Landsbergis, 1988; Su et al., 2009). Stressful work environment has been reported to damage nurses' mental health (Yang et al., 2004), and intention to stay working (Aiken et al., 2002; Jourdain and Chênevert, 2010; Lynn and Redman, 2005). In addition, reduced patients' satisfaction (Leiter et al., 1998; Schmitz et al., 2000) and threatened safety (Cimiotti et al., 2012; Poghosyan et al., 2010) have been associated with nurses' stress.

In addition to its adverse effects on physical health (Cappuccio et al., 2007; Hamer et al., 2012; Shankar et al., 2008), short sleep duration has effects on several domains of psychological health, including stress and burnout in various occupations. In the United States, the national health interview survey conducted in community population found association between short sleep duration ($\leq$ 6 h/a day) and high self-reported stress (Lauren and Phuong, 2007). In Japan, a survey of 8157 men who underwent health evaluations at health management center in Tokyo found that using those who slept 5–7 h as reference group, sleeping shorter than 5 h was associated with higher risk of mental stress (adjusted OR = 1.66, 95% confidence intervals = 1.42–1.96), whereas sleeping longer or equal than 7 h with lower risk (adjusted OR = 0.75, 95% confidence intervals = 0.66–0.85) (Hsieh et al., 2011). A survey among 143 law enforcement officers of the Iowa Department of Public Safety found that subjects sleeping shorter than 6 h had significantly higher burnout and stress scores than those sleeping 6–8 h (p = 0.001 and 0.003, respectively) (Yoo and Franke, 2013).

Similar findings of short sleep duration-associated stress have been documented in healthcare workers. A survey conducted in 150 family medicine residents in Korea found significantly higher scores of occupational stress in those who slept less than 6 h a day (p = 0.005) (Choi et al., 2013). A study in American medical residents showed an inverse dose–response relationship between daily sleep hours and stress level (Baldwin and Daugherty, 2004). Previous studies have shown that short sleep duration is common among nurses (Geiger-Brown et al., 2011, 2012)and healthcare workers (Luckhaupt et al., 2010).

As for the effects of short sleep duration among nurses, studies showed inconclusive findings. A cross-sectional online survey was conducted in *Registered Nurses* (RNs) in the United States to measure their mental, physical, and total fatigue dimensions. Among 745 RNs completed the survey, less sleep was associated with higher scores in physical fatigue and total fatigue, but not those in mental fatigue (Barker and Nussbaum, 2011). A recent study in Finland among 95 nurses and nursing assistants found no difference of sleep length between high strain and low strain group (Karhula et al., 2013). These findings were somewhat different from those in other occupations. Furthermore, in those studies on nurses, a clear relationship of sleep duration and stress has never been clearly described.

Short sleep duration was common among nurses (Linda et al., 2007). In spite of existing studies related to this issue, the establishment of a conclusive relationship between sleep hours and job strain and burnout is still lacking. The aim of this investigation was to assess the prevalence of short sleep in nurses in Taiwan, and the association between sleep duration and reported job strain and burnout by a detailed description of dose-dependent relationship.

2. Methods

2.1. Subjects

We conducted a cross-sectional study among nurses in secondary referral health centers in Taiwan using a self-administered structured questionnaire to obtain information. Stratified sampling was used to select a representative sample of centers for this survey. Considering that severity and complexity of patients' conditions were different between rural and urban areas and between larger centers and smaller hospitals, stratification was undertaken by region and size (Burns and Wholey, 1991; Ross et al., 2010). All secondary referral centers were stratified into four regions, namely, north, central, south, and east. In each region, all secondary referral centers were listed according to the number of beds. Systematic random sampling was used to select approximately 10% of centers from each stratum. A random number between 1 and 10 was generated for each stratum, and then every tenth center was selected.

Table 1
The characteristic of all study participants ($N = 2041$).

Variable	Those included into further analysis ($N = 1384$)	Those excluded from analysis ($N = 657$)
	N (%)	*N* (%)
Age	31.9 ± 8.0	30.8 ± 8.0
≦30 year	754 (54.5)	406 (61.8)
31–40 year	410 (29.6)	160 (24.4)
>40 year	220 (15.9)	83 (12.6)
Missing value	0 (0.0)	8 (1.2)
Marital status		
Single	675 (48.8)	366 (55.7)
Married	671 (48.5)	276 (42.0)
Divorce or widow	38 (2.7)	10 (1.5)
Missing value	0 (0.0)	5 (0.8)
Educational level in nursing[a]		
Professional nursing school (high school level)	79 (5.7)	54 (8.2)
Junior college	788 (56.9)	375 (57.1)
College or above	517 (37.4)	219 (33.3)
Missing value	0 (0.0)	9 (1.4)
Current work tenure	6.6 ± 6.5	6.1 ± 6.6
≦4 years	703 (50.8)	364 (55.4)
5–10 years	388 (28.0)	167 (25.4)
11–15 years	146 (10.5)	58 (8.8)
16–20 years	81 (5.9)	24 (3.7)
>20 years	66 (4.8)	33 (5.0)
Missing value	0 (0.0)	11 (1.7)
Total work tenure	10.4 ± 7.7	9.1 ± 7.6
≦4 years	375 (27.1)	225 (34.2)
5–10 years	452 (32.7)	208 (31.7)
11–15 years	255 (18.4)	104 (15.8)
16–20 years	132 (9.5)	48 (7.3)
>20 years	170 (12.3)	65 (9.9)
Missing value	0 (0.0)	11 (1.7)
Occupational category		
Nurse administrator	134 (9.7)	35 (5.3)
Clinical nurse	1250 (90.3)	619 (94.2)
Missing value	0 (0.0)	3 (0.5)
Responsible for supervising at work		
Yes	327 (23.6)	498 (75.8)
No	1057 (76.4)	118 (18.0)
Missing value	0 (0.0)	41 (6.2)
Employment contract		
Long-term	995 (71.9)	400 (60.9)
Temporary	351 (25.4)	210 (32.0)
Unknown or others	38 (2.7)	42 (6.4)
Missing value	0 (0.0)	5 (0.7)
Salary payment		
Fixed salary	630 (45.5)	282 (42.9)
Fixed salary and bonus	754 (54.5)	373 (56.8)
Missing value	0 (0.0)	2 (0.3)
Percentage of night shift during last year	16.1 ± 22.2	17.8 ± 23.8
≦10%	842 (60.8)	328 (49.9)
>10%	542 (39.2)	231 (35.2)
Missing value	0 (0.0)	98 (14.9)
Being a major earner of family		
Yes	658 (47.5)	297 (45.2)
No	726 (52.5)	331 (50.4)
Missing value	0 (0.0)	29 (4.4)
Living with disabled person		
Yes	53 (3.8)	0 (0.0)
No	1331 (96.2)	0 (0.0)
Missing value	0 (0.0)	657 (100.0)
Having children younger than 6 years		
Yes	336 (24.3)	141 (21.5)
No	1048 (75.7)	442 (67.3)
Missing value	0 (0.0)	74 (11.3)
Exercising regularly		
Yes	528 (38.2)	213 (32.4)
No	856 (61.8)	359 (54.6)
Missing value	0 (0.0)	85 (12.9)
Sleeping hours per working day in last week	6.6 ± 0.9	7.1 ± 2.0
<6	169 (12.2)	83 (12.6)
6–7	888 (64.2)	274 (41.7)
>7	327 (23.6)	237 (36.1)
Missing value	0 (0.0)	63 (9.6)
Job content questionnaire		
Psychological demands (range 23.8–100.0)	64.8 ± 12.8	62.0 ± 12.8
Job control (range 2.7–100.0)	54.7 ± 10.6	54.0 ± 10.9
Active	753 (54.4)	199 (30.3)
Passive	54 (3.9)	31 (4.7)
Low strain	65 (4.7)	21 (3.2)
High strain	512 (37.0)	159 (24.2)
Missing value	0 (0.0)	247 (37.6)
Burnout		
Personal or generic burnout (range 0–100)	59.4 ± 22.0	58.3 ± 22.0
Work-related burnout (range 0–100)	54.6 ± 21.7	54.1 ± 22.3
Client-related burnout (range 0–100)	42.3 ± 18.6	42.2 ± 19.4

[a] In Taiwan, all nurses are required to have formal professional school education, at high school, junior college, or college level. Internship was included in the education, and licensure required passing a national qualification examination. Starting 2004, high school level nursing education was abolished.

After obtaining consent from each selected center, cluster sampling (based on wards/units), rather than simple random sampling, was used to minimize the administrative burden. One contact person from that hospital was identified for disseminating and collecting the questionnaire.

In this study, only female and full-time nursing staffs were recruited, due to a very small percentage of male nurses in Taiwan (less than 1.2%) (The National Union of Nurses' Associations, 2011). In Taiwan, all nurses are required to have formal professional school education, at high school, junior college, or college level. Internship was included in the education, and licensure required passing a national qualification examination. The educational levels are added in Table 1. Starting 2004, high school level nursing education was abolished.

2.2. Questionnaire

2.2.1. Demographic and work characteristics

Demographic characteristics such as age, marital status, educational attainment, financial status, personal life experiences, and work characteristics were collected for analysis.

2.2.2. Job strain

Job strain was assessed using the modified Chinese version of the Job Content Questionnaire (C-JCQ) (Yeh et al., 2008), which was based on C-JCQ and Karasek's control-demand model (Karasek and Theorell, 1990). C-JCQ was asked about the current work condition. The dimensions of psychological demands included 7items (fast work, hard work, excessive work, insufficient time, concentrate on job for long time, hectic work, insufficient manpower) and those of job control included 9 items (learning new things, non-repetitive work, creative work, allowing own decision, high level of skills, freedom to make decision, various tasks, influential opinions, and developing one's abilities). Each item is ranked on a 4-point scale, namely, strongly agree to strongly disagree. Job strain was calculated by dividing the demands score by the control score. In addition, all participants were categorized into four groups, high strain, low strain, active, and passive according to the cut-points in working women from the dataset of a representative survey of all full-time employees in Taiwan in 2007, while excluding those with educational level of lower than high school (Institute of Occupational Safety and Health, IOSH, 2008). The four groups are thus, high strain (high demands and low control), active (high demands and high control), low strain (low demands and high control), passive (low demands and low control). The cut-off values were as follows, high psychological demands: >52.38, low job control: <52.78. In addition, those with high psychological demands and low job control were grouped into high strain group.

2.2.3. Burnout

Burnout status was assessed using the modified Chinese version of the Copenhagen Burnout Inventory (C-CBI), the occupational burnout inventory. In CBI, burnout was defined a status of physical and psychological fatigue and exhaustion. In this study, CBI included: (1) personal or generic burnout (5 items), for measuring the degree of burnout experience by a person for his or her personal life, regardless of his or her work (e.g., "How often do you feel tired?"), (2) work-related burnout (5 items), for measuring the degree of burnout caused by work (e.g., "Do you feel burnt out because of your work?"), (3) client-related burnout (6 items), for measuring the degree of burnout caused by contacts with clients (e.g., "Do you find it hard to work with clients?"). Subjects recalled the frequency of each situation happened in the past week and ranked on a 4-point scale: ranging from always to never. Saleh and Shapiro (2008) reported that work-related burnout rates were approximately 7% in epidemiological studies and health care workers had higher rate. We therefore decide that health care workers with the burnout score $\geq$90th percentile to be considered as the high burnout risk group. The 90th-percentile scores for the personal, work-related and client-related sub-scales were 95, 85 and 65 respectively.

2.2.4. Sleep duration

The sleep duration was obtained by asking subjects to report "average sleep hours per working day during last week." This question originated from an inventory developed by national survey in Taiwan (IOSH, 2008) and has been used extensively in other studies (Cheng et al., 2014; IOSH, 2008), since self-assessed sleep duration was found to yield a valid result compared to quantitative sleep assessment with actigraphy (Lockley et al., 1999).

2.3. Ethical approval

The study was reviewed and approved by the Institutional Review Board (IRB) at the National Taiwan University Medical College, protocol 200812011R, "Working conditions of nursing personnel's at district-level hospitals and below in Taiwan", approved 12/31/08.

2.4. Statistical analysis

Pearson's chi-squared test was used to investigate the association between high job strain and high burnout and each independent (explanatory) variable. Multiple logistical regression was performed to examine the association between predictors such as sleep duration and night shift work and outcomes such as high strain and high burnout. The following potential confounders were considered in the analysis: age, marital status, educational level, occupational category, current work tenure, total work tenure, be a supervisor at work, family situation (major earner of family, living with children under 6 years old, and living with disability), and regular exercise habits. Statistical analyses were conducted using JMP 5.0 (SAS Institute, 1989–2002). The significance level is set at 0.05, for a two-tailed test. For non-linear dose–response relationship, general additive models (Hastie and Tibahirani, 1986) (GAM) was used to examine the relationship between sleep duration and adjusted job strain and burnout scores. GAM uses a non-linear link function to establish a relationship between the mean of the outcome and a smoothed function of exposure variables (Desquilbet and Mariotti, 2010; Guisan et al., 2002). Natural cubic splines with 10 degrees of freedom were applied to detect the best model shape by using R free software (R Statistic, 2012).

3. Results

There were 366 secondary referral health centers in Taiwan according to 2005–2008 accredited hospital lists in Taiwan (Ministry of Health and Welfare, 2009). Totally, 39 hospitals were selected by the stratified sampling scheme (13 from north, 10 from central, 14 from south, and 2 from east of Taiwan). A total of 3292 full-time female nurses were employed in the participating hospitals. After excluding nurses on extended leave and vacation, and refusals, only 2268 nurses received the questionnaire and 2041 (90%)

Table 2
The number (percent) of participants with high job strain and high burnout by each demographic category ($N = 1384$).

Variable	*n*	High strain ($n = 512$) *n* (%)	High personal burnout ($n = 159$) *n* (%)	High work-related burnout ($n = 159$) *n* (%)	High client-related burnout ($n = 167$) *n* (%)
Age					
≦30 year	754	302 (40.0)	98 (13.0)	106 (14.0)	110 (14.5)
31–40 year	410	148 (36.1)	43 (10.4)	39 (9.5)	47 (11.4)
>40 year	220	62 (28.1)	18 (8.1)	14 (6.3)	10 (4.5)
p value		0.005	0.107	0.002	0.001
Marital status					
Single	675	266 (39.4)	89 (13.1)	98 (14.5)	96 (14.2)
Married	671	234 (34.8)	66 (9.8)	56 (8.3)	64 (9.5)
Divorce or widowed	38	12 (31.5)	4 (10.5)	5 (13.1)	7 (18.4)
p value		0.177	0.153	0.001	0.014
Educational level					
High school or professional school	84	27(34.1)	12 (15.1)	10 (12.6)	15 (18.9)
Junior college	796	320 (40.6)	94 (11.9)	98 (12.4)	95 (12.0)
College or above	533	165 (31.9)	53 (10.2)	51 (9.8)	57 (11.0)
p value		0.010	0.534	0.512	0.118
Current work tenure (year)					
≦4	703	293 (41.6)	77 (10.9)	83 (11.8)	102 (14.5)
5–10	388	123 (31.7)	52 (13.4)	49 (12.6)	38 (9.7)
11–15	146	54 (36.9)	21 (14.3)	19 (13.0)	19 (13.0)
16–20	81	23 (28.4)	3 (3.7)	4 (4.9)	5 (6.1)
>20	66	19 (28.7)	6 (9.0)	4 (6.0)	3 (4.5)
p value		0.003	0.091	0.182	0.016
Total work tenure (year)					
≦4	375	162 (43.2)	47 (12.5)	51 (13.6)	62 (16.5)
5–10	452	176 (38.9)	58 (12.8)	57 (12.6)	56 (12.3)
11–15	255	86 (33.7)	30 (11.7)	28 (10.9)	29 (11.3)
16–20	132	42 (31.8)	11 (8.3)	13 (9.8)	13 (9.8)
>20	170	46 (27.0)	13 (7.6)	10 (5.8)	7 (4.1)
p value		0.002	0.289	0.100	0.001
Occupational category					
Nurse administrator	134	15 (11.1)	16 (11.9)	14 (10.4)	12 (8.9)
Clinical nurse	1250	497 (39.7)	143 (11.4)	145 (11.6)	155 (12.4)
p value		<0.001	0.863	0.691	0.244
Responsible for supervising at work					
Yes	327	71 (21.7)	42 (12.8)	41 (12.5)	45 (13.7)
No	1057	441 (41.7)	117 (11.0)	118 (11.1)	122 (11.5)
p value		<0.001	0.379	0.495	0.281
Employment contract					
Long-term	995	334 (33.5)	107 (10.7)	100 (10.0)	113 (11.3)
Temporary	351	158 (45.0)	47 (13.3)	52 (14.8)	50 (14.2)
Unknown or others	38	20 (52.6)	5 (13.1)	7 (18.4)	4 (10.5)
p value		<0.001	0.391	0.021	0.345
Percentage of night shift during last year					
≦10%	842	286 (33.9)	84 (9.9)	89 (10.5)	87 (10.3)
> 10%	542	226 (41.7)	75 (13.8)	70 (12.9)	80(14.7)
p value		0.004	0.030	0.180	0.013
Being a major earner of family					
Yes	658	250 (37.9)	90 (13.6)	81 (12.3)	86 (13.0)
No	726	262 (36.0)	69 (9.5)	78 (10.7)	81 (11.1)
p value		0.463	0.015	0.361	0.275
Exercising regularly					
Yes	528	176 (33.3)	55 (10.4)	50 (9.4)	56 (10.6)
No	856	336 (39.2)	104 (12.1)	109 (12.7)	111 (12.9)
p value		0.027	0.326	0.064	0.190
Sleeping hours per working day in last week					
>7	327	106 (32.4)	29 (8.8)	29 (8.8)	33 (10.0)
6–7	888	329 (37.0)	94 (10.9)	92 (10.3)	104 (11.7)
<6	169	77 (45.5)	36 (21.3)	38 (22.4)	30 (17.7)
p value		0.016	<0.001	<0.001	0.040

Comparisons were made by Chi-square test using strain or burnout (high vs. non-high) as dependent variables, and demographic categories as independent variables. *p*-Values to three decimal places are shown in columns, if the *p*-value is less than 0.001 use $p < 0.001$.

returned questionnaires. Only respondents who answered all the questions were included in the final analysis sample ($n = 1384$, 60%). Among those who returned the questionnaire, those included and excluded were not different in terms of age, education, marriage, work tenure, sleep hour, job strain, and burnout (Table 1).

Demographic characteristics, job description, job content questionnaire, and burnout scores of study population are summarized in Table 1. Mean age of the participants was 31.9 years (SD = 8.0). Nine tenth of the participants were clinical nurses (90.3%) and the average working tenure was 10.4 years as a nurse. Approximately two fifth worked night shifts for >10% of all shifts during the past 12 months. The mean of average sleep duration per working day in last week is 6.6 h. 12.2% of nurses slept less than 6 h after a working day in the last week.

In the JCQ of this study, the Cronbach's alpha coefficients for internal consistency were 0.78 for psychological

Table 3
Mutually adjusted odds ratio of potential confounders with job strain and burnout ($N = 1384$).

Variable	*n*	High strain AOR (95% CI)	High personal burnout AOR (95% CI)	High work-related burnout AOR (95% CI)	High client-related burnout AOR (95% CI)
Age					
≦30 year	754	1.0	1.0	1.0	1.0
31–40 year	410	1.0 (0.7–1.4)	0.6 (0.4–1.0)	0.5 (0.3–0.9)	0.7 (0.4–1.1)
>40 year	220	0.9 (0.5–1.4)	0.5 (0.2–1.1)	0.3 (0.1–0.8)	0.2 (0.0–0.5)
p value		0.728	0.168	0.028	0.001
Marital status					
Single	675	1.0	1.0	1.0	1.0
Married	671	1.0 (0.7–1.3)	0.7 (0.4–1.0)	0.5 (0.3–0.8)	0.8 (0.5–1.2)
Divorce or widowed	38	0.9 (0.4–2.0)	0.7 (0.2–2.2)	1.0 (0.3–2.8)	1.8 (0.6–4.6)
p value		0.797	0.293	0.021	0.136
Current work tenure (year)					
≦4	703	1.0	1.0	1.0	1.0
5–10	388	0.7 (0.5–1.0)	1.5 (1.0–2.3)	1.4 (0.9–2.2)	0.6 (0.4–1.0)
11–15	146	1.0 (0.6–1.6)	2.1 (1.1–4.0)	2.4 (1.2–4.7)	1.3 (0.6–2.5)
16–20	81	0.9 (0.4–1.6)	0.4 (0.0–1.4)	0.8 (0.2–2.4)	0.8 (0.2–2.1)
>20	66	0.8 (0.4–1.6)	1.4 (0.4–4.2)	1.3 (0.3–4.4)	0.9 (0.1–3.3)
p value		0.299	0.348	0.061	0.246
Occupational category					
Nurse administrator	134	1.0	1.0	1.0	1.0
Clinical nurse	1250	0.3 (0.1–0.6)	1.4 (0.6–2.9)	1.0 (0.5–2.4)	0.8 (0.3–1.6)
p value		0.001	0.348	0.702	0.568
Responsible for supervising at work					
No	1057	1.0	1.0	1.0	1.0
Yes	327	0.5 (0.4–0.8)	1.1 (0.7–1.9)	1.3(0.8–2.2)	1.6 (1.0–2.6)
p value		0.002	0.456	0.168	0.020
Employment contract					
Long-term	995	1.0	1.0	1.0	1.0
Temporary	351	1.2 (0.9–1.6)	1.1 (0.7–1.7)	1.3 (0.9–2.0)	1.0 (0.6–1.5)
Unknown or others	38	1.7 (0.8–3.3)	1.1 (0.3–2.8)	1.7 (0.6–4.4)	0.6 (0.2–1.8)
p value		0.084	0.699	0.192	0.776
Percentage of night shift during last year					
≦10%	842	1.0	1.0	1.0	1.0
>10%	542	1.1 (0.8–1.4)	1.2 (0.8–1.8)	0.9 (0.6–1.3)	1.1 (0.8–1.6)
p value		0.451	0.217	0.741	0.352
Being a major earner of family					
No	726	1.0	1.0	1.0	1.0
Yes	658	1.1 (0.9–1.5)	1.5 (1.1–2.2)	1.2 (0.8–1.8)	1.2 (0.9–1.8)
p value		0.139	0.009	0.174	0.159
Exercising regularly					
No	856	1.0	1.0	1.0	1.0
Yes	528	0.8 (0.6–1.0)	0.8 (0.6–1.2)	0.7 (0.5–1.0)	0.8 (0.6–1.2)
p value		0.128	0.518	0.124	0.468
Sleeping hours per working day in last week					
>7	327	1.0	1.0	1.0	1.0
6–7	888	1.2 (0.9–1.6)	1.2 (0.8–1.9)	1.2 (0.8–1.9)	1.1 (0.7–1.8)
<6	169	1.8 (1.2–2.7)	3.0 (1.7–5.2)	3.4 (2.0–6.0)	2.0 (1.2–3.6)
p value		0.012	<0.001	<0.001	0.02

p-Values to three decimal places are shown in columns, if the *p*-value is less than 0.001 use $p < 0.001$.

demands and 0.69 for job control. The mean scores of psychological demands and job control were 64.8 (SD = 12.8) and 54.7 (SD = 10.6), respectively. Using the national medians of psychological demands (52.38) and job control (52.78) (Institute of Occupational Safety and Health (IOSH), 2008) as the cut-off points, the participants' job contents were classified into four groups, i.e., active (n = 753, 54.4%), passive (n = 54, 3.9%), low strain (n = 65, 4.7%), and high strain (n = 512, 37.0%).

The Cronbach's alpha coefficients for internal consistency were 0.92 for personal or generic burnout, 0.93 for work-related burnout, and 0.87 for client-related burnout. The mean scores of personal, work-related, and client-related burnout were 59.4 (SD = 22.0), 54.6 (SD = 21.7), and 42.3 (SD = 18.6), respectively.

Table 2 presents the associations of demographic and work characteristics with high job strain and high burnout status. High strain was associated with younger age, junior college graduates, being a clinical nurse, lower tenure in current job or being a nurse, temporary employment contract, higher % of night shifts, lacking of exercise, and not responsible for supervising at work. High personal burnout was associated with higher % of night shifts, and being a major earner of family. High work-related burnout was associated with younger age, unmarried, less stable employment contract. High client-related burnout was associated with younger age, unmarried, lower tenure in current job or being a nurse, higher % of night shifts. Salary payment, living with disabled person, and having children less than six years old were not found to contribute significantly to differences in high or low job strain and burnout (not shown in table).

The significant predictor variables from Table 2 were then entered into a multiple logistic regression analysis (Table 3). After adjusting for other significant variables, nurses with average sleep duration of shorter than 6 h per working day had higher risk of job strain compared with those sleeping longer than 7 h (adjusted odds ratio, AOR = 1.8, 95% confidence interval, CI = 1.2–2.7). For personal burnout, work-related burnout, and client-related burnout, similar higher risks were seen for short sleep time, with AOR of 3.0 (CI = 1.7–5.2), 3.4 (CI = 2.0–6.0), and 2.0 (CI = 1.2–3.6), respectively. We also took another cut-off value for night-shift, that those who reported more than 45% shifts were night-shifts. We did not find higher strain or higher burnout among those with 45% night shifts or more as compared to others (not shown in the table).

Figs. 1–4 show the nonlinear relations between job strain, burnout, and sleep duration. Longer sleep duration was strongly related to lower job strain (Fig. 1) and client-related burnout (Fig. 4) in a rather linear manner. On the other hand, personal (Fig. 2) and work-related (Fig. 3) burnout were related to sleep duration with plateau phenomena at sleep duration of longer than 7 h or shorter than 5 h. We also fit cubic spline function to assess the association between sleep duration and job strain/burnout. For strain vs. sleep duration, the linear term was significant, but the quadratic and cubic terms were non-significant. For burnouts vs. sleep duration, all quadratic and cubic terms were statistically significant.

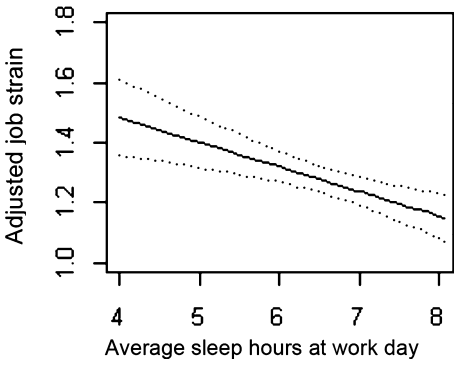

Fig. 1. Job strain (Psychological demand/job control) and average sleep hours in working day during last week. (Best fitting cubic spline with 95% CI.) 1.97 – 0.11 (sleep hours) + 0.02 (sleep hours)^2 – 0.01 (sleep hours)^3 95% CI for intercept, linear term, quadratic term, and cubic terms were (1.40 – 2.54), (−0.20 to −0.02), (−0.03 to 0.07), and (−0.03 to 0.05). (N = 1384).

4. Discussion

In this group of nurses representative of those worked at secondary hospitals in Taiwan, we found that sleep duration on working days was associated with job strain and burnout, with optimal sleep duration at 7 h or longer. Although interpretation of these results into causal relationship has to be cautious, such findings provide valuable indicators for job stain and burnout status when sleep time is short among nursing staff.

Our findings were compatible with a study by Rutledge et al., in which shorter sleep duration predicted higher emotional stress score on the second day in physicians and nurses (Rutledge et al., 2009). In a national survey among post-graduate year (PGY)1 and PGY2 residents in the US, one year experience was inquired, and the average sleep time was negatively related to level of stress (Baldwin and Daugherty, 2004). A Korean study on 11 interns and 47 residents found dose-related stress level comparing subjects with severe (slept less than 4 h per day), moderate

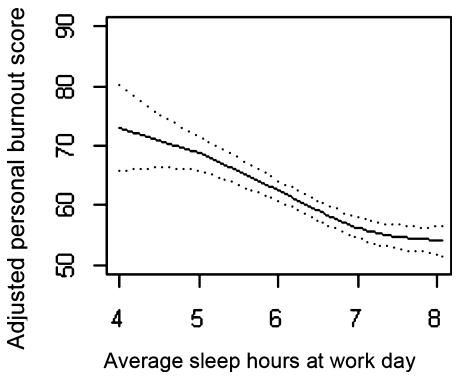

Fig. 2. Personal burnout and average sleep hours in working day during last week. (Best fitting cubic spline with 95% CI.) 102.40–6.74 (sleep hours) + 1.79 (sleep hours)^2 + 1.04 (sleep hours)^3 95% CI for intercept, linear term, quadratic term, and cubic terms were (87.93–116.87), (−8.98 to −4.50), (0.45–3.13), and (0.12–2.96). (N = 1384).

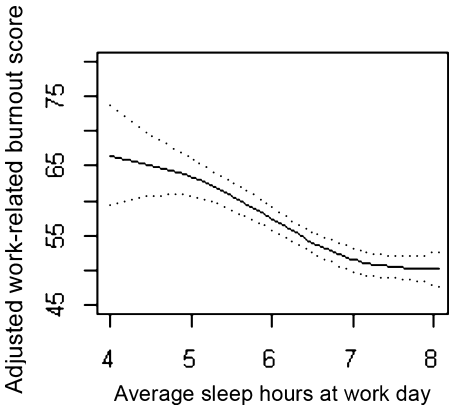

Fig. 3. Work-related burnout and average sleep hours in working day during last week. (Best fitting cubic spline with 95% CI.) 94.85–6.33 (sleep hours) + 1.83 (sleep hours)^2 + 1.04 (sleep hours)^3 95% CI for intercept, linear term, quadratic term, and cubic terms were (80.50–109.2), (−8.55 to −4.11), (0.50–3.16), and (0.13–1.95). (N = 1384).

(slept 4–6 h per day), and no sleep deprivation in the past two weeks (Kim et al., 2011). Our study added information to this last study by providing observable effects when dose of sleep deprivation was lower, namely sleep duration of 6–8 h. Up to the sleep time of 8 h, any reduction of sleep time caused observable effects on strain. On the other hand, the effects of sleep reduction on burnout seemed to plateau for sleep time of 7 h or longer.

Confirmation of a relationship between sleep duration and burnout has so far been inconclusive. In physicians in primary care centers in Madrid, sleep duration was found to be shorter among those with high burnout scores than those with low burnout scores by using Shirom-Melamed Burnout Questionnaire (SMBQ) (Vela-Bueno et al., 2008). However, a clear dose–response relationship was not provided in that study. In a study among workers in an information-technology industry, burnout score for the

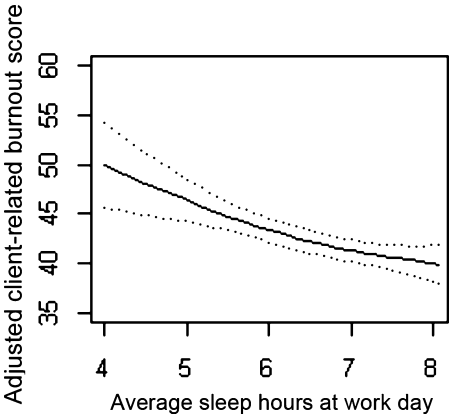

Fig. 4. Client-related burnout and average sleep hours in working day during last week. (Best fitting cubic spline with 95% CI.) 66.05 − 3.78 (sleep hours) + 1.46 (sleep hours)^2 + 0.88 (sleep hours)^3 95% CI for intercept, linear term, quadratic term, and cubic terms were (53.71–78.39), (−5.69 to −1.87), (0.32–2.60), and (0.09–1.67). (N = 1384).

modified version of SMBQ was found to be unrelated to sleep duration (Söderström et al., 2004) but the number of participants was small (n = 24). Rather small number of participants among the total workers employed might have caused some uncertainty of the results. In 336 hospital physicians in Japan, a cross-sectional survey using Maslach Burnout Inventory (MBI) was carried out to assess burnout. Shorter sleep duration was correlated with higher emotional exhaustion score (Tokuda et al., 2009).

Continual sleep deprivation has been shown to increase fatigue and stress in human experiments. Thirteen healthy young men completed a sleep restricted study. The participants, with average ideal nightly sleep of 7.4 h, had their nightly sleep limited to 5.0 h per night for seven consecutive nights. Stress and mental exhaustion assessed by visual analog scales in each morning after waking and each night before bed showed increased scores in fatigue and stress (Dinges et al., 1997). The sleep hours for participants in our study (Figs. 1–4) encompassed the range of scores found in that study (Dinges et al., 1997) but also provided clearer evidence of a dose-dependent relationship.

Insufficient sleep in healthcare workers might have adverse effects on the quality of healthcare. A cross-national investigation in six countries found high level of nurses' burnout was associated with lower rating of quality of care (Poghosyan et al., 2010). In Canada, an investigation in two healthcare setting found a relationship between nurses' exhaustion and patients' dissatisfaction (Leiter et al., 1998). A survey conducted in the US found significant association between burnout in nurses and healthcare associated infections in inpatients (Cimiotti et al., 2012). The authors estimated a potential annual reduction of 6239 infections if the number of nurses with high burnout could be reduced by 30% in these hospitals.

Our study has particular strengths. First, the participants were drawn from a nationally representative sample of nurses working in secondary referral centers in Taiwan. Second, a non-linear fitting method allows for the dose related estimation of severity of burnout and job strain according to sleep duration. However this study did have limitations. First, the study design was cross-sectional; therefore causal relationship could not be established. We can only conclude that there is an association between short sleep duration and job strain/burnout. In this study, the number of hours worked during the previous week was not collected. However, shorter sleep duration has been related to long working hours (Dahlgren et al., 2006; van der Hulst, 2003). On the other hand, reciprocal mechanisms cannot be ruled out, since stress from the job can cause burnout, as well as sleep problems including sleep deprivation. Since among nurses in Taiwan long working hours and relatively irregular shifts have been reported (Chiou et al., 2013; Lin et al., 2014), these might have contributed to short sleep duration, and warranted further investigation. Secondly, the subjects of this study were nurses working in secondary referral centers and thus might not be representative of all nurses currently working in Taiwan. Thirdly, we did not specifically ask our participants whether, and how often, they were talking sleeping pills. The frequency of sleep pill use among female

nurses was found related to work-related stress (Pikó, 1999). It is possible that the effect of short sleep on job stain and burnout might have been underestimated in our study. Fourthly, we only recruited female nurses to participate this study. Therefore our result cannot be applied to male nurses. Fifthly, we did not examine some potential confounding factors such as drinking and smoking in this study. However, the reported prevalence rate of alcohol drinking (regular drinking less than 4%) (Yang et al., 2001) and smoking (current smoker less than 1%) (Lally et al., 2008; Yang et al., 2001) were low among nurses in Taiwan. Therefore we did not expect these factors would affect our results. Sixthly, the sleep duration on non-working days was not assessed in this investigation, which might have caused some misclassification in overall sleep debt, as sleep duration on working days was usually shorter than non-working days (Basner et al., 2007; Dorrian et al., 2006, 2008), implying compensation for sleep debt in non-working days. However, the aim of this study was to examine the relation between sleep and job strain and burnout, thus sleep duration on working days are more relevant. This is supported by studies which showed the primary importance of immediate sleep history on human cognitive performance and psychological health (Dorrian et al., 2008, 2011; Lastella et al., 2012; Leibenluft et al., 1996; Okun et al., 2013). We therefore do not believe lacking of information of sleep duration on non-working days caused bias in our main findings that short sleep was related to strain and burnout. Finally, in this study, we had high response rate (90%). However, those non-responding to the questionnaire could have been more occupied, and were too busy to participate in this study. Therefore this study might have underestimated the prevalence of short sleep duration. Since those who did not participate might have high strain and high burnout, the relation between sleep duration and strain/burnout might not have been distorted.

In conclusion, this study found dose-dependent associations between short sleep hours per working day with job strain, and personal, work-related, and client-related burnout. According to our findings, female nurses are advisable to sleep for at least 6 h per day in order to minimize their job strain and burnout. Further investigation on work factors which may affect sleep hour and quality is warranted.

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